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Influence of Varying Environment on Rice Varieties under Upland Condition of Madhya Pradesh, India

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A B S T R A C T

The field experiment was conducted during *Kharif* season of 2018 at Research farm, Department of Physics and Argo-meteorology, College of Agricultural Engineering, JNKVV, Jabalpur (M.P.). Aim of the study is to evaluate the performance of rice cultivar under varying environment. Keeping 3 dates of sowing *i.e.*, 15th June, 30th June and 15thJuly under main plots and four rice varieties *viz.*, MTU 1010, Sahbhagi, Kranti and IR 36 in sub plot with thrice replications. The experiment was laid out in split plot design. The direct seeded rice sown on 15th June was found most favourable for all 4 rice cultivar and maximum mean yield was option under this date of sowing. Among the rice cultivar the Kranti performed significance superior over rest of varies at all dates of sowing. Results revealed that direct seeded rice sown on 15th June recorded significantly higher grain yield (3742 kg ha^{-1}) as compared to 30th June (3482 kg ha^{-1}) and 15th July (3065 kg ha^{-1}). Rice variety Kranti showed significant superiority over other varieties under all the three dates *i.e.*, 15th June, 30th June and 15th July sowing in terms of grain yield. The net monetary returns and B: C ratio were found to be the maximum (Rs.39736 ha^{-1} and 2.0, respectively) under Kranti variety sown on 15th June.

Keywords

Dates of sowing, Varieties, Direct seeded rice, Yield and Economics

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Introduction

Rice (*Oryza sativa* L.) plant belonging to the family of *Poaceae* (*Gramineae*). It is the most important staple food in Asia, providing average 32% of total calorie uptake (Singh *et al.*, 2019a and Singh *et al.*, 2019b).Worldwide, rice is grown on 167 mha, with an annual production of about 769.65 million tonnes of paddy (FAO, 2017). India accounts for 22.3% of the world's production of rice. India is the 2nd largest producer and consumer of rice in the world. At present, 43.19 million hectare area is under rice crop in India with the production of 109.70 million tonnes and the productivity of 2550 kg ha^{-1}(Anonymous, 2017). In Madhya Pradesh, rice is grown in about 2.02 million hectare area with the production of 3.58 million tonnes which clearly indicates that the productivity of rice is quite low *i.e.*, 1768 kg ha^{-1}(Anonymous, 2016). Based on the hydrology and topography of land, the rice area is classified into various ecologies *viz.*, rainfed upland (16%), irrigated medium land (45%) and rainfed low land (39%).Rice crop needs a hot and humid climate. It is best suited to regions which have high humidity, prolonged sunshine and an assured supply of water.Direct seeding technique offers a useful option to reduce the limitations of transplanted rice (Pingali *et al.,* 1994). Direct seeding can also reduce the risk by avoiding terminal drought that lowers the yield of transplanted rice, especially if the latter is established late due to delayed rainfall. Direct seeding can facilitate crop intensification (Singh *et al.*, 2008).

Under upland condition, an early maturing variety of 100-110 days duration *e.g.* Sahbhagi, MTU 1010, Annapurna, Jagruthi are grown, while under irrigated lowland condition medium to long duration varieties like Kranti, IR-36, Madhuri are generally preferred. In direct seeded rice the medium or late maturing varieties suffer due to water stress at maturity stage. The reasons of low productivity of rice in rainfed lowland ecosystem are many and varied. Therefore, keeping in view all above facts the present investigation entitled influence of varying environment on rice varieties under upland condition.

Materials and Methods

The field experiment was conducted at Research Farm, Department of Physics and Agro-meteorology, College of Agricultural Engineering, JNKVV, Jabalpur (M.P.) during *Kharif* season of 2018.The climate is sub-humid, sub-tropical and featured by hot dry summer and cool dry winter. The soil of experimental field was sandy clay loam in texture and neutral in reaction (pH 6.72) with low electrical conductivity (0.06 dS/m) and medium in available N (285 kg ha^{-1}), P (17.45 kg ha^{-1}), K (260 kg ha^{-1}) and organic carbon (0.82%). The field experiment was laid out in split plot design with replicated thrice. The treatments comprised of three dates of sowing(15th June, 30th June and 15th July) in main plots and four varieties (MTU 1010, Sahbhagi, Kranti and IR 36) in sub plots. Seed of rice were sown on June15th, June30th and July 15th by direct seeded in lines 20 cm apart keeping a seed rate of 60kg ha^{-1}. All recommended package and practice for nutrient, water and weed management were adopted to grow the rice crop. The seeds were treated with Bavistin @ 2gkg^{-1} seed before sowing.

Results and Discussion

Effect of dates of sowing

Data given in Table 1 indicated that, the dates of sowing significantly influenced the yield attributes of rice. Sowing on 15th June gave significant highest number of effective tillers (361 m^{-2}), length of panicle (24.58 cm), number of filled grains panicle^{-1} (128), weight per panicle (3.06 g) and 1000 grain weight (22.81 g) as compared to30th June effective tillers (354 m^{-2}), length of panicle (23.63 cm), number of filled grains panicle^{-1} (125), weight panicle^{-1} (2.90 g) and 1000 grain weight (22.44) and 15th July effective tillers (334m^{-2}), length of panicle(21.65 cm), number of filled grains panicle^{-1} (119), weight panicle^{-1}(2.85 g) and 1000 grain weight (20.72).This may be due to availability of favourable soil and air temperature during growing cycle of the crop. Under late sowing condition the shortened the growth period of the plant which reduced the leaf area, length of panicle and number of filled grainspanicle^{-1} than early sowing. Number of filled grains penicle^{-1}was found in the decreasing trend from the seeding of 15thJune onward. Grains panicle^{-1} showed better response with early sowing (Biswas and Salokhe, 2001). Besides, a reduction in the grain filling rate was also noted under low temperature. This show that the environmental condition likes temperature, humidity is most favourable for grain development in early transplanting as compared to delay transplanting (Akbar *et al.*, 2010).Early seeding (15 June) had the highest 1000-grain weight and decreased as sowing delayed. 1000-grain weight decreased gradually with delay in planting time.

The dates of sowing significantly influenced the grain yield of rice. Sowing on 15th June recorded maximum grain and straw yield (3742 and 6737 kg ha^{-1}, respectively) which was significantly higher than the grain and straw yield under as 30th June (3482 and 6556 kg ha^{-1}, respectively) and 15th July (3065 and 6203 kg ha^{-1}, respectively).

The higher paddy yield was attributed to more number of effective tillers, more number of filled grains panicle^{-1} and increased 1000 grains weight. Delay in sowing results in reduction of plant height, productive tillers, filled grain panicle^{-1} and grain yield as also was reported by Shah and Bhurer (2005). The higher yield for early sowing was mainly due to favourable climatic conditions especially at the time of tillering, flowering and grain filling (Jagtap *et al.*, 2017). Table 1 indicated that with each delay in sowing of rice, there was significant decrease in grain yield of rice during the crop seasons. Similar results were reported by Dhaliwal (2006) and Mahajan (2009). Rice grain yields declined as seeding date was delayed (Hwang *et al.*, 1998).

Effect of varieties

Data presented in Table 1 revealed that, at harvest stage, among the varieties Kranti produced significantly highest effective tillers (370 m^{-2}) as compared to Sahbhagi (354 m^{-2}) and IR 36 (341 m^{-2}), while MTU 1010 variety gave lowest effective tillers (330 m^{-2}). Among the varieties Kranti produced significantly higher length of panicle (24.71 cm) as compared to Sahbhagi (23.53 cm) and IR 36 (22.71 cm), while MTU 1010 exhibited minimum length of panicle (22.19 cm), which was at par to that of IR 36. Among the varieties Kranti recorded significantly higher number of filled grains panicle^{-1} (130) followed by Sahbhagi (123), IR 36 (123) and MTU 1010 (118). Variation in filled grains panicle^{-1} was observed due to genotypic differences of varieties. Similar results were reported by earlier worker Kumhar *et al.*, 2016a and Kumhar *et al.*, 2016b. Among the varieties Kranti exhibited significantly weight panicle^{-1} (3.36 g) as compared to Sahbhagi (2.97g) and IR 36 (2.76g), while MTU 1010 variety exhibited lowest weight of per panicle (2.65 g).

The 1000 grain weight (g) of different varieties varied significantly. Variety Kranti (23.98) recorded significantly maximum test weight over others. Among the varieties Kranti produced significantly higher grain and straw yield (3938 and 6901 kg ha^{-1}, respectively) as compared to Sahbhagi (3407 and 6448 kg ha^{-1}, respectively) IR 36 (3241 and 6319 kg ha^{-1}, respectively) and MTU 1010 (3134 and 6328 kg ha^{-1}, respectively). Applying additional irrigation at flowering stage besides managing under rainfed situation improved grain yield of Kranti variety as was also reported by Bedi (2012).The results are in the conformity with the work done by Padhi (1995) and Mahajan (2009).

Interaction effects

Data presented in Table 2 revealed that, the interaction effects between dates of sowing and different varieties were found to be significant in respect of grain and straw yield (kgha^{-1}) of rice. Variety Kranti under 15th June sowing gave highest grain and straw yield (4263 and 6964 kg ha^{-1}, respectively) which was significantly superior over other treatment combinations. However, variety MTU 1010 under 15th July sowing gave minimum grain yield of 2734 kg ha^{-1}.

Table.1 Effective tillers, panicle length, filled grain panicles^{-1}, grain weight panicle^{-1}, test weight (1000 grain weight), grain and straw yield of rice as influenced by different dates of sowing and varieties

Treatments	Effective tillers m^{-2}	Panicle length (cm)	Filled grains panicle^{-1}	Grain weight panicle^{-1} (g)	Test weight (g)	Grain yield (Kg ha^{-1})	Straw yield (Kg ha^{-1})
Dates of sowing							
D1-15th June	361	24.58	128	3.06	22.81	3742	6737
D2-30th June	354	23.63	125	2.90	22.44	3482	6556
D3-15th July	334	21.65	119	2.85	20.72	3065	6203
SEm±	**1.0**	**0.9**	**0.29**	**0.01**	**0.11**	**43.65**	**89.07**
CD at 5%	**4.2**	**0.36**	**1.17**	**0.04**	**0.46**	**175.92**	**359.11**
Varieties							
V1-MTU 1010	330	22.19	118	2.65	21.03	3134	6328
V2-Sahbhagi	354	23.53	123	2.97	22.00	3407	6448
V3-Kranti	370	24.71	130	3.36	23.98	3938	6901
V4-IR 36	341	22.71	123	2.76	21.66	3241	6319
SEm±	**2.0**	**0.19**	**0.30**	**0.01**	**0.11**	**23.15**	**50.89**
CD at 5%	**6.0**	**0.57**	**0.91**	**0.04**	**0.46**	**69.32**	**152.38**

Table.2 Interaction effect of the sowing times and varieties on grain yield (kg ha^{-1}) and Straw yield (kg ha^{-1}) of direct seeded rice (DSR)

Treatments	Grain yield (kg ha^{-1})				Straw yield (kg ha^{-1})			
	15th June	**30th June**	**15th July**	**Mean**	**15th June**	**30th June**	**15th July**	**Mean**
MTU 1010	3426	3240	2734	3134	6727	6390	5868	6328
Sahbhagi	3735	3435	3049	3407	6642	6413	6289	6448
Kranti	4263	3948	3602	3938	6964	6919	6820	6901
IR-36	3542	3307	2875	3241	6615	6504	5838	6319
Mean	3742	3482	3065		6737	6556	6203	
	D	V	D×V	V×D	D	V	D×V	V×D
SEm±	**43.6**	**23.1**	**55.7**	**87.2**	**89.0**	**50.8**	**117.3**	**178.1**
CD(P=0.05)	**175.9**	**69.3**	**202.4**	**145.5**	**359.1**	**152.3**	**421.4**	**316.6**

Table.3 Cost of cultivation, gross monetary returns, net monetary returns and B: C ratio of different dates of sowing and varieties under direct seeded rice

Treatments	Cost of cultivation (Rs. ha^{-1})	Gross monetary returns (Rs. ha^{-1})	Net monetary returns (Rs. ha^{-1})	B: C ratio
Dates of sowing				
D1-15th June	39236	78960	39736	2.0
D2-30th June	38536	74063	35527	1.9
D3-15th July	37836	66042	28206	1.7
Varieties				
V1-MTU 1010	37836	67494	29658	1.8
V2-Sahbhagi	37836	72512	34676	1.9
V3-Kranti	39236	82717	43481	2.1
V4-IR 36	39236	69364	30128	1.8

The higher grain yield in 15th June sown crop may be attributed to better plant growth leading to significantly more number of tillers m^{-2}, number of grains panicle^{-1}, number of effective tillers m^{-2}, number of filled grains panicle^{-1} and 1000-seed weight (g) just because of better partitioning of photosythates compared to delayed sowing dates. Delay in sowing results in reduction of plant height, effective tillers, filled grain panicle^{-1} and grain yield as also was reported by Shah and Bhurer (2005). Sartori *et al.*, (2013) also obtained highest yield from early sown rice crop whereas poorer grain and straw yield were obtained from late sown rice. Short photoperiod induces high partitioning of assimilates to rice grains as was also reported by Pallavi *et al.*, (2018).

Economics of the treatments

The economic indices calculated for various treatments have been given in Table 3. Sowing of upland rice on 15th June proved most beneficial giving maximum net monetary returns of Rs. 39736 ha^{-1} with B: C ratio of 2.0. Fifteen days delay in sowing *i.e.*, 30th June resulted in reduced net monetary returns of Rs. 35527 ha^{-1} with B: C ratio of 1.9. Under 15th July, the net monetary returns was further reduced to Rs. 28206 ha^{-1} with B: C ratio of 1.7. Late sowing adversely influenced the yield and there by net monetary returns. These results are in accordance to the findings of Singh *et al.*, (1997) who reported that net monetary returns and benefit cost ratio were also higher in case of 15 June sowing. In case of rice varieties, Kranti proved its superiority by giving highest net monetary returns up to Rs. 43481 ha^{-1} with B: C ratio of 2.1. However, the second best variety was Sahbhagi giving net income up to Rs. 34676 ha^{-1} with B: C ratio of 1.9. The third best variety was IR 36 nearby giving net monetary returns up to Rs. 30128 ha^{-1} with B: C ratio of 1.8 and MTU 1010 giving lowest net monetary returns up to Rs. 29658 ha^{-1} with B: C ratio of 1.8. Accordingly the 15th June sowing of Kranti variety proved to be the most remunerative with the net monetary returns of Rs. 48593 ha^{-1} and B: C ratio of 2.2. A difference in net monetary returns from different varieties has also been reported by Singh (2006) and Jain and Upadhaya (2008).

From the experiment, it is concluded that the optimum sowing date for direct seeding of upland rice variety Kranti is 15th June for getting maximum yield and net monetary returns, while delay in sowing after 30th June and 15th July reduce the yield gradually. Growth, yield attributes and grain yield of direct seeded rice were affected by dates of sowing. The maximum grain yield of 3742 kg ha^{-1} was found under 15th June sowing, which was significantly higher over the yield under 30th June (3482 kg ha^{-1}) and 15th July (3065 kg ha^{-1}). All the varieties showed higher yield in 15th June sowing while reduction in growth, yield attributes and grain yield with successive 15 days delay in sowing. Rice variety Kranti showed more remunerative other varieties under all the three dates *i.e.*, 15th June, 30th June and 15th July sowing in terms of grain yield.

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